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July 12, 1993

Secretary
Federal Communications Commission
Washington, D. C. 20554

Re: PETITION FOR RULE MAKING BY GENERAL MOTORS RESEARCH CORPORATION

Attached is an original and nine copies of our Petition for Rule Making, covering our request to amend Code of Federal Regulations, Title 47, Parts 2 and 15 of the Rules, to allocate radio spectrum for automotive radar.

This request has been reviewed with Mr. Paul Rinaldo, AARL Congressional Liaison, Washington, D.C.,

Should you have any questions or require additional information, please contact the writer at the above address. My telephone and facsimile numbers are also provided for your convenience.

Sincerely,

Lois A. Williams
Vice President

Copies: Richard Engelman, Chief, Technical Standards Branch
John Reed, Engineer, Technical Standards Branch
Thomas Stanley, Chief Engineer, Engineering & Tech.

PETITION FOR RULE MAKING

BY

GENERAL MOTORS RESEARCH CORPORATION

SUMMARY

This is a request to amend Parts 2 and 15 of FCC Rules to establish regulations, measurement standards and a frequency assignment for commercial radar. Specifically, our request is to have the 76-77 GHz band allocated for a forward-looking radar system. The radar we are developing is frequency modulated continuous wave (FMCW). By our calculations, the maximum field strength is 430 mV/m @3m. Emissions outside 76-77 GHz will be attenuated at least 60 dB below the fundamental frequency.

This system will detect objects in front of a vehicle and can be used to alert the driver to potentially hazardous situations within the field of view of the radar. It can also be used to control headway by means of automatic control of the throttle and brakes. However, our initial application of this product will only have a driver alert function. We plan to have this equipment developed and approved for marketing within a 2-3 year time frame.

We selected 76-77 GHz predicated on a proposal by The Council of European Communities, specifically the European Radio Community Committee, identifying this spectrum for radar and future road transport telematic systems. Since this is in line with the allocation of use foreseen in the Radio Regulations of the International Telecommunications Union (ITU), we believe that the radar we are developing will meet the proposed European standards. In addition, we have had informal discussions with agencies of the Federal Government, selected automotive manufacturers as well as other interested parties with regard to our intent to file this request, and we have received no objection to the use of this frequency.

INTRODUCTION

Sophisticated technologies are increasingly being applied to the solution of every day problems. In particular, the automotive industry is constantly searching for ways to improve safety, enhance driver convenience, and lessen the environmental impact of millions of cars on our roads and highways. The use of forward-looking radar technology adapted from the aerospace and defense industry offers significant potential for positively impacting all three of these areas via crash avoidance systems, aided cruise control, and enhanced fuel economy. To fully realize the promise of these new applications of radar technology, frequency spectrum must be made available for its use.

Background

General Motors has developed several test bed Adaptive Cruise Control (ACC) radar systems operating under an Experimental Radio Service license at 60 GHz, for the purpose of investigating the use of forward-looking radar on passenger and commercial vehicles. ACC is an enhancement to cruise control which assists the driver by maintaining the proper separation between the host vehicle and others in its path. This is accomplished by application of a radar sensor that determines the distance and relative velocity to other vehicles. This information is used to control the throttle and, if necessary, lightly apply the brakes. An alert is provided when driver action may be required to maintain proper separation.

The current phase of this program is focused on cost reduction for the commercial market worldwide by reducing the size of the hardware, targeting the largest possible market, and developing low cost designs and technologies. The first product that we are planning to market is a driver alert radar for trucks and buses. It will only function to warn the driver of potentially hazardous situations in the path of the vehicle. It will not be used to control throttle or brakes.

We are proposing to operate within a 1 GHz band width with a center frequency of 76.5 GHz. There are two reasons for selecting this frequency:

1. Increasing from 60 to 76.5 GHz will reduce antenna aperture dimensions by the ratio 60/76.5 for the beam width we have chosen. (For a given beam width, antenna aperture is inversely proportional to frequency.) This helps us to achieve our goal of minimizing sensor size.

2. The European community has identified spectrum at 76-77 GHz for forward-looking radars to be used in Europe. Our GM development organization, Hughes Electronics, is working with GM Adam Opel A.G. in Europe, in order to develop a common product for both the United States and Europe. Use of the same spectrum will enable us to produce the same product for marketing in the United States as well as Europe, thereby lowering unit cost for all customers. It will also eliminate the need to develop radars at different frequencies to serve both markets, thus minimizing non-recurring costs.

Request

We are requesting the 76-77 GHz band be allocated for this purpose. We submit that our product is extremely stable and will not create interference to existing or potential future operations. In addition, it will not generate out-of-band interference, and is not susceptible to mutual interference with radars mounted on other vehicles.

Safety

Our radar uses frequency modulated continuous wave (FMCW) transmission. Our detailed analysis indicates that the maximum power density in the near field is far below the Federal Safety Standard. Our calculations show that the worst case maximum field strength is 430 mV/m @ 3m. (We expect to confirm our field power density predictions in November of this year, at which time we will be able to measure the maximum transmitted electromagnetic field strength of our first test unit.) Further, the radar transmitter is disabled when the vehicle is not moving forward. Consequently, people will not be exposed to the transmitter's radiation at short ranges when the vehicle is in operation.

Interference

An inquiry to National Telecommunications Information Administration (NTIA) indicates there are two assignments in the 76-81 GHz band - both are non-government users.

They are:

1. Georgia Institute of Technology (33-54-31 N., 08-43-144 W.). This system has an emission designator of NON and a rated output power of 100 watts, and is used at the antenna test range.

2. The second assignment is to the United States government but is operated by Bell Labs in New York and New Jersey. This system has a rated output power of 20 Watts and an emission designator of NON, 25M0F7D, 25M0F8E, 25M0F8F, and 25M0F9W. The system is used for research with communication system equipment for common carrier and related services.

Consequently, we believe that these existing users will not represent a bar to our proposed use of 76-77 GHz.

We are aware of the fact that the 76-81 GHz band is reserved for use by licensed amateur stations and as indicated in our covering letter our proposal has been reviewed with a representative of the AARL. Although there is no 76-81 GHz amateur radio equipment in use at present, it is completely reasonable and proper to anticipate that this band will some day be used by amateur radio stations. However, operation of the forward-looking radar will not interfere with other radar or potential amateur users for the following reasons:

1. Our radar uses wide band FMCW modulation with a very narrow intermediate frequency (IF) band width.
2. These characteristics, together with low transmit power and a narrow beam antenna, preclude interference with other radio equipment.

Furthermore, our proprietary modulation scheme ensures that there is near zero probability that two of our radars will interfere with each other. This is due to the non-synchronous frequency modulation of approximately 200 MHz with a processing band width in the tens of kilohertz. Tracking filters prevent any disruption of performance. (Hughes has applied for a patent on the modulation scheme.) Antenna performance will be measured on a free-space antenna range with calibrated equipment traceable to a secondary standard. Radiated power will be verified by an EMI test set and at our EMC Proving Ground facilities.

Frequency Stability and Out-of-Band Operations

Frequency stability and out-of-band operations are concerns primarily for pulsed radar systems that use crystal or stabilized oscillators. The continuous wave form of an FMCW modulation scheme does not generate the higher frequency harmonics associated with pulsed radars. It is expected that emissions outside 76-77 GHz will be attenuated at least 60 dB below the fundamental frequency. Our test procedure for determination of spurious or harmonic emission measurements is by a down-converted signal to a Hewlett Packard Model 8566 spectrum analyzer with the setting at 3 MHz resolution band width and 1 MHz video band width. Measurements will be made over the entire 76-81 GHz band.

Out-of-band operation, beyond 76-77 GHz is limited by the voltage control oscillator. In operation, the frequency is swept through less than 200 MHz of the 1 GHz allocation, i.e., less than 20% of the available band width. The additional frequency band width is to compensate for drift due to temperature changes.

Conclusion

We believe we can finalize development of a radar for the commercial market in 1-3 years. However, in order to do so, substantial investments must be made between now and initial production of equipment. Consequently, we must determine in advance of such investments whether there are any prohibitions that would ultimately prevent our use of this spectrum. Thus, our request for a Petition for Rule Making at this time.